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Technical Report
on
REGIONALIZATION OF THE ARCTIC REGION, SIBERIA,
AND THE EURASIAN CONTINENTAL AREA USING
SEISMIC SURFACE WAVES

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Principal Investigator: Professor Leon Knopoff

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Under our previous AFOSR contract we developed a seismic regionalization in which the area under investigation was described in terms of six, laterally homogeneous, subregional models. The purpose of the current contract is to improve the resolution of the seismic parameters, as a function of depth, in each of these models. It may also be necessary to improve our placement of the boundaries that separate the different subareas of our initial regionalization.

1. "The Inversion of Surface Wave Dispersion Data with Random Errors" by L. Knopoff and F.-S. Chang. This paper has been submitted and accepted for publication in the Journal of Geophysics (Zeitschrift für Geophysik). In this paper the ability to use a given set of dispersion data to resolve certain upper mantle model parameters is investigated through the expedient



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of computing dispersion for a known structure, adding random phases to the result, and then performing an inversion; we use the known structure as the starting model in the inversion. If the phase errors are random and uncorrelated, then the variances in the group velocities are much larger than in the phase velocity determinations. For fundamental mode Love and Rayleigh wave phase and group velocities determined over the range 20 to 250 sec, phase velocity data are considerably more potent resolvents of upper mantle structure than group velocity data. For a continental structure, Love and Rayleigh wave phase velocity data over the same period band have comparable ability to resolve structure, except for low-velocity channel thickness, for which Rayleigh wave data have superior resolution; for an oceanic structure, the two types of dispersion data also give comparable resolution except for lid thickness, for which Rayleigh waves have superior resolution.

2. "Relative Errors in Group Velocity Measurements" by L. Knopoff. This paper has been submitted, and accepted for publication in the Journal of Geophysics Zeitschrift für Geophysik). In this paper the estimates of error in measurement of group velocities for a

dispersed surface wave train are shown to be a strong function of the nature of the dispersion curve. At periods near a group velocity extremum, group velocity measurements give greater resolution of earth structure than do phase velocity measurements; for periods removed from such extrema, group velocity measurements give unacceptably large errors, at ordinary distances from an earthquake focus.

3. "Interpretation of Oceanic Sn" by E. Mantovani, F. Schwab, H. Liao and L. Knopoff. This paper has been submitted and accepted for publication in the Geophysical Journal of the Royal Astronomical Society.

In this paper we treat the short period seismic phase Sn that has been interpreted by Stephens and Isacks (1977) as a "lid wave" in which the seismic energy is constrained to the uppermost few tens of kilometers of the mantle. We have extended their normal-mode interpretation for structures both with and without low-velocity zones in the upper mantle; we have used spherical, anelastic models of the earth. For a model with a LVZ we agree that Sn is a lid wave for sources above 200 to 250 km, if only the onset of Sn is considered. The later portions of the Sn wave train sample the structure as deeply as the "420-km" discontinuity. For deeper foci,

the pseudo-lid wave does not appear to be generated; even the onset of Sn samples the deeper mantle structure. For a model without a LVZ, in general, sources at all depths above the 420-km discontinuity appear to generate teleseismic Sn which samples the entire mantle as deeply as the discontinuity and which travels with a velocity significantly greater than the lid velocity. Thus the velocity of Sn may be an important diagnostic to determine whether or not a low-velocity zone exists in the upper mantle.

4. "Surface-Wave Dispersion Computations: Rayleigh Waves on a Spherical Gravitating Earth" by F. Schwab, G. F. Panza, H. M. Liao, E. G. Kausel and J. Frez. This paper has been submitted for publication in the Bulletin of the Seismological Society of America. In this paper algorithmic and numerical analyses are carried out for Rayleigh-wave dispersion computations on a spherical, gravitating earth. Our work is based on the direct, Alterman-Jarosch-Pekeris formulation. For practical purposes, we fix period and determine the associated phase velocity (or polar order number). Neither this, nor integration downward from the free surface -- both "non-standard" procedures -- results in

unexpected difficulties. The latter procedure yields a simplification of the computational algorithm, the clarity of which allows it to be extended to group-velocity evaluations. The AJP, direct-integration formulation is optimized and compared with the fastest -- Knopoff's method -- of the techniques based on the flat, homogeneous-layer approximation. The optimized form of the AJP method (spherical) is three times slower than Knopoff's (flat, non-gravitating) method when gravity is included in the AJP formulation; and is 1.36 times slower when gravity is not included. Additional programming would reduce the former estimate to a lower bound of 2.42 times slower, and the latter, to a lower bound of 1.30. In size and number, the treatment of integration "steps" in the direct-integration procedure, is equivalent to the treatment of "layers" in the homogeneous-layer approximation; thus the usual assumption that the former method does a better job of treating continuous parameter-depth distributions, appears to be invalid. Overflow problems in the AJP formulation can be controlled by simple normalization. Loss-of-precision problems appear to be intrinsic to the AJP formulation. At a fixed period, this results

in the attainable accuracy of the phase velocity decreasing as mode number increases; and, for fixed accuracy in the phase velocity, as period decreases the maximum mode number that can be treated successfully decreases.

The results of our contract work for the months of January February, and March of 1977 are scheduled to be presented in two talks at the April meeting of the Seismological Society of America. This information will be contained in our next Technical Report.